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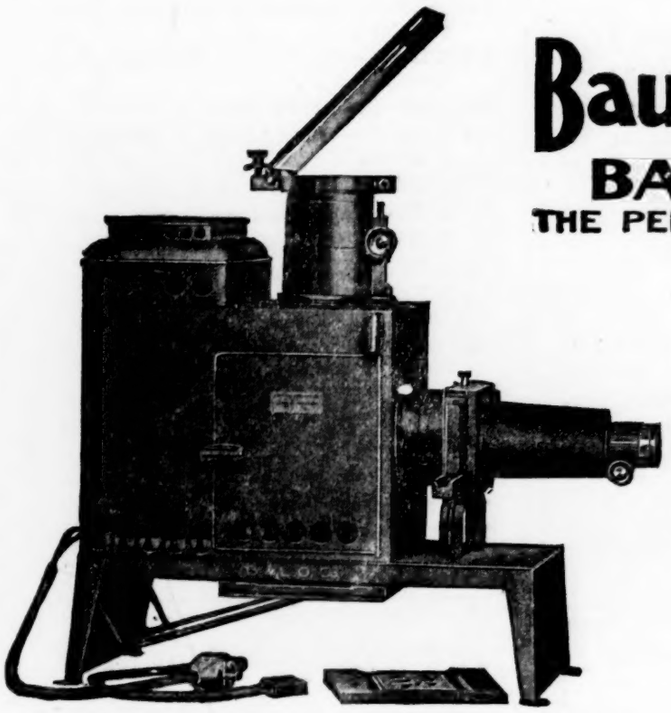

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SCIENCE

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THE SCIENTIFIC MOBILIZATION IN ITALY FOR THE WAR

THE various manifestations of the present war have had, for the most part, their foundation in applied science and industry. The best minds turned to study methods of offense and defense, based on the application of pure or applied science, and inventive genius has had and still has a wide field in which to find new arms and new devices and to perfect those now existing.

From the beginning of the war, Italy, no less than her Allies, has mobilized her scientific and industrial forces for the one purpose to which all the activities of the country have had to be devoted, and nothing has been spared to help and perfect the great war-machine which *had to* bring victory.

The work began first individually and as demanded by the necessities of the moment; then, a little at a time, for individual work, for the work of individual scientists as officers on the fighting line or in the rear where their technical skill was required, or in the war industries which had to enlarge all their plants rapidly and modify them according to circumstances, there was substituted a single organization, a state institution. This was founded in order to mobilize properly for war purposes all available Italian scientific forces and all the means at the disposal of the numerous laboratories of the schools and state technical establishments.

This institution, which naturally was situated at the Ministry of Arms and Munitions, had the following duties:

(1) To classify and mobilize the various scientific institutions according to their possible utilization and the means at the disposal of each. (2) To study the problems which were eventually proposed by the military technical offices, distribute them to the laboratories and institutions best adapted to the particular

problem, follow the various experimental phases, especially in the case of inventions worthy of attention. The institution was in this way the connection between the military offices and all those who had improvements to propose on the methods of war then existing or new applications or inventions. When the experiments had advanced to such a point of development as to be utilized, it transmitted the results to the military offices for application. (3) To take charge of the shops already mobilized for war work and to adapt others as the need arose. (4) To take care of the completed inventions and researches and the unsuccessful attempts, of the problems overcome and of those yet to be overcome, seeking to improve what already existed and to create new things without repeating long and fatiguing work. (5) To collaborate closely with the analogous institutions of the allies, by means of specially appointed delegates who had to keep informed of the progress made in the various problems, and follow the scientific movement in the allied countries.

The institution thus conceived was definitely established at the beginning of 1916 under the name of Office of Inventions and Research, acting as a department of the Ministry of Arms and Munitions, and under the direction of Senator V. Volterra, who was the authorized proposer and founder. The Minister of Education then authorized the directors of the universities, the heads of the other institutions of higher instruction, and the directors of the scientific and experimental bureaus to put themselves at the disposal of this office, and to correspond directly with it in order that predetermined objectives might be attained most rapidly. In the same way the mobilization was started of the scientific and technical department of our higher institutions of learning, and their relative personnel, with the exception of clinical and other similar institutions engaged in medical work, and they now work assiduously and efficiently.

Some of the institute directors came to Rome to form part of the central office, to coordinate and select the work according to the special aptitude of the personnel of the various local institutions, and the quality of material there available for the researches.

Along with the studies and researches on problems of various kinds and of immediate necessity, the study of inventions was brought under scientific supervision. We should notice that in large part the cases concern proposals made by persons who know little or nothing about the problem which their invention attempts to solve. For a group of those competent, it is easy to exclude, from the enormous number of inventions presented, those that have no foundation; then they may study those for which there is hope of succeeding. On the other hand, these same persons are in a position to engage themselves, each one in the branch of science in which he is most interested, studying the same problems and directing the line along which the same class of inventions must be worked out. More than that, it has been necessary to conduct systematic researches in order to learn the availability in Italy of the raw mineral products needed for certain war-productions; this problem was immediately attacked by our best mineralogists and geologists.

In this way the office promises also to be an institution of permanent utility when the present conflict has ceased and the work of the civilized world is again directed toward more profitable purposes of peace.

For evident reasons the moment for unveiling the results of the work of the Italian scientists for the war has not yet come. But at least we can give the names of the most efficient cooperators of Senator Volterra. Among them these ought to be remembered: Lori Nasini, Miolati, Piola, Fano, Vacca, Millosevich, Corbino, Occhialini, Trabacchi, Ciamician, Angeli, Martelli, Vinassa, Aloisi, Carrara, Dalla Vedova; of our universities and in the military and naval world, Avallone, Valsecchi, Vitali, Buffa and many others.

Although apparently there is no lack of persons and the already available methods are utilized as largely as possible, they are not sufficient. What must be done in Italy on a much larger scale than has been done heretofore is to bring scientific research into direct

relation with industry. The example given us by the United States, which has produced and knows how to produce on such a vast scale without losing sight of scientific research, must be followed to the farthest possible limit. The great industries of Ansaldo, Pirelli, Fiat, the Galileo factories, the Filotecnica, the Rossi Electrochemical factories, and many others which are based on the studies and researches conducted for years by the Italian scientists and engineers, are now having the opportunity to continue their work with the assistance of research laboratories which will perfect, increase and improve their production along lines peculiar to these establishments. But if it were possible for these laboratories to specialize in some branch of pure science without an immediate application, it would all be for the moral and educational gain of the establishment itself and still more of the country.

By means of the special representatives sent to the allied countries, we have been able to compare, step by step, with those made in our country, the conditions and development in the various Allied countries, the improvements made, and the researches which have increased and bettered the methods of offense and defense. Our cooperation with the United States has been and still is of great interest. Though they are geographically very far from the theater of war and have thus lacked the advantage of knowing at each moment what was needed and which ways were the most useful to follow, still their great richness of means and of materials have made it possible that from them and them alone could come that help which has brought us to victory. And close cooperation in scientific and technical matters is of the same importance as that exclusively military. The researches which we could begin with our better knowledge of the necessities and problems which were constantly arising on earth and on sea and in the air, could immediately be developed here where means and materials are not lacking.

When the great struggle is completely at an end, it will be possible to enumerate for the sake of history and as a help in times of peace, the studies and researches made; then we will see what an amount of work has been accomplished and what part has been taken by Italian scientists and engineers in the field of mathematics, and its application in ballistics, in engineering, in electrotechnics, in the natural sciences, in chemistry, in the navy, in artillery, in aeronautics. Notable results have already been attained in utilizing raw materials, which we could dispose of at home or in our colonies, and certain minerals have been discovered which are used in producing steel.

The progress made by Italy in aeronautics is already known. Especially in the construction of aeroplanes have notable results been obtained recently, by employing a *Sva* engine which has been evolved through the cooperation of theory and practise at the Direzione Tecnica dell' Aviazione at Turin. And that this collaboration was necessary and perfect is demonstrated by the aerodynamic qualities of this engine and its exceptional characteristics of flight—especially the small velocity necessary to support it in the air and its great stability.

In the field of dirigibles and of aerial artillery the Central Aeronautical Institute in Rome, which already long before the war had made and published aerodynamic studies under the direction of Crocco, Ricaldoni, Prassone, Bianchi and many others, was ready to do their share in the present war, in which the operations of our dirigibles have been universally noted. These dirigibles, which are certainly among the most perfect engines of their kind, are the results of long years of theoretical and practical study at the Institute of Rome. The aerial artillery, under Volterra and Crocco, has had a beginning which will make it a powerful weapon as soon as we can use it on a large scale on airships of any type.

Aerial navigation was made the object of special study, particularly on the part of astronomers, the necessary instruments were constructed, and for its practical application, courses for aviation pilots were instituted. The tables for the determination of the point, the lessons in aeronautics by Bianchi, and the

route indicator devised by Crocco might be mentioned in passing.

Meteorologists of the Army and of the Weather Bureau organized an Aerologic Service for the immediate use of the fighting armies on earth, on sea, and in the air, and specially interesting are the new methods for forecasting developed by Vercelli of the University of Turin.

In the field of marine engineering, especially in light craft for offense and defense, very notable results have been reached—from the engines to the hulls. In radiotelegraphy, naval and physical engineers have invented new instruments for the detection of submarines, and have sought to improve those already existing, in complete cooperation with the allies.

In wireless especially, the institutes of the Ministry of Posts and Telegraphs in Rome and that of the Royal Navy at Livorno have contributed to the study and to the improvement of the communication between the different belligerent units on earth, sea and air, and of transoceanic communication. Vallauri, of the Electrotechnical Institute of the Royal Navy, has published in the *Nuovo Cimento* a study on the functioning of vacuum tubes with three electrodes called *audion,* which can be considered as a first attempt at the theory of these tubes, which have many applications today in wireless.

In optics, precision laboratories were established under the direction of scientific men and the construction of optical instruments for war uses was improved in a notable manner. It may be sufficient to call to mind the work of the Galileo factory at Florence, especially in searchlights, periscopes and sighting instruments in general, the Filotecnica of Salmoiraghi in Milan, and the precision laboratory for the artillery in Rome.

For the sound ranging problem—that is, the determination of the position of the enemy artillery by sound—Garbasso, after the beginning of the war, founded the phonotelemetric service for use of our artillery, and in it several of our young physicists have found a field for technical and practical work.

In the field of photography there existed before the war a photographic section of the army, well known, especially for the works of Tardivo in telephotography and aerial phototopography. These immediately found application in war, and no matter whether from the air or the ground or the sea the photographic explorers, using the good apparatus designed and constructed by the section itself, contributed genuinely to knowledge of the enemy positions. Telephotography, especially in the regions of the Alps, was much used, and, when the censorship permitted, the results were in small part published, as for example in the panoramas of the war prepared under the direction of the Supreme Command of the Army.

Corbino and Trabacchi improved the working conditions of X-ray tubes, together with the application of devices for producing currents of high tension and of constant direction especially adapted to control them.

It was clear that Italian chemistry was ready when called upon. The already existing factories for explosives were enlarged and other large ones established, and our best chemists showed they knew how to push ahead and direct them, introducing new methods and courageously starting new ways of working. The numerous chemists who were selected for these war industries have given excellent account of themselves, as well as those who have been directing other industries also now engaged in war service.

Through the initiative of Prince Piero Ginori Conti, interesting studies have been made by Nasini and his students of the boraciferous "soffioni" of Larderello and of all the problems concerning boric acid, its byproducts and the gaseous emanations of the soffioni already used in various ways. The volcanic energies of our soffioni, unconquered and yet conquered by the will of man, donate to national industry with generous and singular abundance, boric acid, ammonia, carbonic acid, radioactive emanations, heat, vapor and pressure. Illuminated minds and generous hearts knew how to transform desolate and frightful regions into busy and prosper-

ous industrial centers, where every day the vapors let out into the atmosphere are steadily diminished, but the amount conveyed in pipes, conquered and utilized in every way, increases.

On account of the growing difficulty in importing nitrates from Chile, much has been done in Italy in regard to the problem of nitrogen, but its solution, important in time of war for explosives, in time of peace for agriculture, has been by no means easy, although we may mention the Rossi Factory of Legnano, gratified to-day by merited success along this line. The air has no political boundaries, and its nitrogen has no owners; it is this nitrogen which has to serve to fertilize our ground, which has to give us nitric acid for our industries. Our abundant waters, which are our natural wealth, must some day, when systematized and rendered obedient, supply the electricity necessary to feed uninterruptedly the cycle of nitrogen, to return the precious element from the inexhaustible atmospheric reservoir to the ground to intensify the agriculture and the life of our country, without limitations of commerce, of treaties, of transports, of possible mineral exhaustion.

Among the electrochemical industries, we have firmly established in Italy that of calcium carbide, and in electrosiderurgy, the Stassano electric furnaces, by means of which we have attained success in preparing many special steels and ferro-silicon. By means of the electrolysis of fused salts we produce aluminium in a certain quantity.

The dye industry has resorted to the preparation of certain simple colors; it has revived the manufacture of vegetable dyes and obtained brilliant results.

A problem for which Italy has found no solution is that of fuel, although we have tried all possible means to improve and increase to the utmost the few resources of our miserly soil. How insoluble the problem is can be understood by comparing the 800 thousand tons of poor combustible which our soil produces with the 11 million tons of fossil which we have to import in normal times, for the greatest part from England. To improve, to the greatest degree possible, this state of affairs, studies have recently been made of the hydraulic problems and the necessary legislation in regard to the waters, for the purpose of utilizing in the best possible way, our resources of white coal, which, in part at least, free us from the necessity of importing black coal from abroad.

An interesting study on the subject of black and white coal in Italy has been published by Novarese of the University of Rome in the *Atti della Società Italiana per il Progresso delle Scienze* in 1916. The extraction and the use of our fossil coals known by the name of *picee* or *black* and *xiloid* or *brown* lignites, have received during these years of war a very decided impetus, the unjustifiable objection to them, which the consumer has always had, having been overcome. The study of the various fields and their coordinate utilization has been of great advantage for war purposes in times of difficulty, and has demonstrated that our lignites, save for the manufacture of coke, to which they are not adapted, could be substituted, as far as there was an available quantity, for the imported fossil coals in all the uses to which they are applied in our country, and in not a few cases with noticeable advantages. Along this line, especially important are the recent studies made in the United States on the use of pulverized coal and on combustibles in general, on the subject of which a vast and interesting amount of material has been published in the *General Electric Review*.

According to Novarese our very modest reserve will acquire considerable value if, in the coordination of services which must come in the production of hydroelectric energy, it is employed as an auxiliary source to supply the deficiencies which are experienced in all hydroelectric plants more or less every year in periods of ordinary or extraordinary scarcity of water. Our coal, therefore, ought to represent a reserve for extraordinary needs, whether due to meteoric changes, or to other causes.

In order to make use of our hydraulic energy, the various sources available are being studied, and both the surface and the under-

ground hydrography of our country. The Institute of the "Regio Magistrate alle Acque" of Venice, similar to the one which existed at the time of the glorious Republic, and that of the commission for the study of hydraulic regulation of the Po river are examples of activity in this problem, activity which has already led to noteworthy results in several regions of Italy. An important study of the evolution of dikes for artificial lakes in high mountains has been made by Dr. L. Luiggi, with interesting comparisons between the dikes constructed in the various countries of the world, especially in the United States, and conclusions on the mountain dikes in the high valleys of the Alps and Apennines. In these valleys it may be possible to make numerous artificial lakes, in order to utilize better our hydraulic resources, whether to create electric energy, destined especially for the electrometallurgical and electrochemical industries, or to fertilize arid ground which, if irrigated properly, would produce more and better, or merely to drain unproductive or malarious regions, which with mechanical drainage could rapidly be put under cultivation.

The steel industry, which can not be attempted by us on the vast scale it is in other nations rich in iron and coal, has increased noticeably. During the war the siderurgical production of Italy was almost doubled in comparison with preceding years. We did not need to make changes in technical processes, but we completed plants for producing metallurgical coke and furnaces with apparatus for the extraction of by-products, increased the number of electric furnaces for steel, and constructed new hydroelectric plants or made use of energy from other societies already established.

In the medical sciences, the mobilization of the whole personnel and all the scientific resources in the country has met admirably the needs of the war; in our organized medical service, which is considered one of the best in existence, we have also found the time and means to make interesting researches and publish reports on them. The physiologists occupied themselves essentially with the problem of alimentation, and a scientific committee which applied itself to the various questions connected with the subject was appointed. During the war the studies and experiments of the physiologist Lo Monaco of the University of Rome were made on the action of sugar on the bronchial secretions. According to these studies, sugar in solution inoculated under the skin of those suffering from respiratory diseases, determines a rapid decrease in the quantity of bronchial secretion, which is gradually reduced until finally it ends completely.

In the field of the economic and political sciences, our studies and discussions on the principle of nationality are especially interesting at this moment. Senator Francesco Ruffini brought to light and discussed in one of his lectures another lecture given January 22, 1851, by Pasquale Stanislao Mancini, while exiled by the Bourbons, with which he inaugurated the first course in international law given in Italy. The title of Mancini's lecture is "On Nationality as Foundation for the Law of the People," and it has remained famous in the history of International Law, constituting probably the most modern and original page of the science of public law which has been written by an Italian hand in the past century. The economists and the men of letters of "Italia irredenta" have contributed in an efficient manner to the study and knowledge of all the problems which should find their natural solution in these times.

In the geological and geographical sciences, publications for actual and immediate use have been edited, such as the Report of the Commission for the study of Albania, and the studies on Dalmatia and Alto Adige. The Royal Italian Geographic Society has published the studies and conferences of Baratta, Taramelli, Martelli, Dainelli, Vinassa, Sillani and Tamaro, showing the Italian characteristics of those regions and presenting the justice of our aspirations.

Although this review is necessarily incomplete, yet it may be an incentive to look into the future and foresee what must be done to

continue the collaboration between the scientific and industrial elements of the country and the exchange of proposals and the united action for scientific and moral progress between the allied countries, specially what concerns the United States and Italy, who, during this war, have had opportunity to know and appreciate each other more thoroughly than before.

The institution, which, in the United States, is parallel to our Ufficio Invenzioni e Ricerche and the analogous institutions in France and England, is the National Research Council founded by Dr. G. E. Hale, which works as a scientific and research office acting as a department of the Council of National Defense.

In regard to the cooperation of the United States with the Allied countries we remember that on the entrance of the United States into the present struggle the following telegram was sent by Dr. Hale, foreign secretary of the American National Academy of the Sciences to the Royal Society of London, the Académie des Sciences, to the Accademia dei Lincei of Rome, and to the Russian Academy of Sciences, namely, to all the important scientific units with which the American Academy has cooperated for many years in the International Association of Academies:

> The entrance of the United States into war unites our men of science with yours in a common cause. The National Academy of Sciences acting through the National Research Council, which has been designated by President Wilson and the Council of National Defense to mobilize the research facilities of the country, would gladly cooperate in any scientific research still underlying the solution of military or industrial problems.

As a result of this invitation missions composed of men of science were exchanged by the various allied nations and a research information committee was established in the National Research Council, represented at Rome, Paris and London by scientific attachés at those embassies. Exchange of ideas and progress in their common work have been and are still continuous and constant. and, speaking especially of Italy, they have brought their results, although greater progress is expected with the increase in exchange of persons, ideas and facts.

The extended program of Dr. Hale for an interallied research council also plans for after the war an interallied institution that provides the means of reaching a common agreement as to what researches are most vital and ought to be begun because of the pressure of economic necessity or in light of recent progress, and has the privilege of selecting the countries or institutions best adapted to undertake certain researches and of finding the best methods to coordinate the work of the investigators of the different countries. This project was presented by Dr. Hale with complete success at the meeting of the academies in London. Thus were laid the foundations for a cooperation which will surely be fruitful of results, especially in the long work of readjustment and reconstruction which is going to begin with the desired conclusion of peace in the world.

GIORGIO ABETTI

ITALIAN WAR MISSION,
WASHINGTON, D. C.

THE PERSONAL RELATION OF THE INVESTIGATOR TO HIS PROBLEM[1]

As president of the local chapter it is my privilege to welcome you to membership in Sigma Xi and to say a few words concerning the main purpose of the society, the furthering of original investigation in science. I shall confine myself to the question of the personal relation of the investigator to his problem.

As a preliminary consideration it is well to emphasize the unlimited possibilities of scientific investigation. I have been asked by a member of our faculty, not in scientific branches, what scientists will do when they have discovered everything that is to be known about natural phenomena. The obvious answer is of course that instead of approaching such a consummation we are rapidly moving away from it. The number of things to be

[1] An address to newly initiated members of Sigma Xi at the University of Illinois, May 21, 1919.

investigated with profit is rapidly increasing and there is no reason to believe that there will ever be a change in this condition. The solution of any problem merely opens up new problems and the number of problems that can be effectively attacked is increasing in a geometrical progression. The formulation of new problems is therefore as much a function of research as the solution of problems already formulated.

Considering these facts we must realize that what we call the known is merely an infinitesimal part of what is to be known. Our systems of classifying facts, our so-called laws, are based upon partial views of the universe. At any time they may need revision. We should have no sympathy with the point of view expressed to me by one of my teachers when I was beginning graduate work in zoology. He said it was too bad that we were born too late, that we were living at a time when the great laws of biology had been discovered. He was referring to Darwin's theory of natural selection and went on to add that all we could hope to do was to elaborate upon Darwin's work and find additional examples of the law he had discovered. This remark of his has since reminded me of my boyhood regret that I had been born after all the great earthquakes and volcanic eruptions and great wars were over and I saw nothing ahead but a calm and dreadfully uninteresting future.

To my mind if there is anything that is clear it is that the great discoveries in science are still to be made, that while there has been great progress it is just a beginning. Nothing can be more fatal to our careers as investigators than the view that we are simply to elaborate the principles laid down by our predecessors. The whole spirit of research should be a continual revolt against this view, a continual attempt to find new and better modes of interpretation of phenomena. I feel safe in making this appeal because there will always be plenty of people who will follow the path of least resistance and they can be depended upon to pave the beaten paths and keep them smooth by rolling back and forth their truck loads of confirmatory observations.

Let me illustrate the value of the scientific imagination by an example from the biological field. One of the central problems in the field has been the question of the manner in which children obtain their hereditary qualities. The problem has been studied from two sides. On the one hand, an analysis of the adult characters of the children as compared with those of their parents and grandparents has disclosed certain so-called laws of heredity. On the other hand, a careful study of the minute structures and activities of cells, particularly of the sex-cells, has been made to see if the mechanism of heredity could be discovered. Each of these fields has yielded and continues to yield results of the greatest importance. It is interesting to find out that following crosses between certain kinds of individuals we may expect to get in the second hybrid generation certain kinds of individuals in definite ratio, but interest soon flags in the elaboration of the system and in the carrying out of the idea in endless variety. Likewise studies without end have been made of the microscopical structure of nucleus and cytoplasm, of chromosomes and centrosomes, of chromomeres and chondriosomes. The determination of a system by which we might describe the endless variety and relations of these structures is a task for numerous lifetimes.

The problems in these two fields are set. How easy to follow the beaten path, to polish off a paving stone here and there, to gain merited attention by developing a technique which will bring out some structures better than they had ever been seen before. But, whose soul is now fired by a new Mendelian ratio or by a new chromosomal number? Research in these lines became more and more a matter of routine, less and less inspiring, and there was danger that in these fields as in some others the investigators' main satisfaction would come from having faithfully put in his hours from eight to five. Why does he want to work overtime? Certainly not for the pleasures of contemplation of the beaten path. The inspiration comes from a vision of untrodden fields.

Returning to the example under consideration we find that the great spurts in the advance are due to the stimulation of the scientific imagination by hypotheses which aim to bridge the gulf between the two lines of research. The idea of a connection between the fact of the general equality of male and female parents in heredity, and the fact of equality in the nuclei of the male and female sex-cells was of epoch-making importance. Later the association of the precise though complicated behavior of the nuclear bodies called chromosomes with the possibility that these bodies are the bearers of the hereditary factors again caused a tremendous advance along both of the lines we have mentioned. More recently still, the hypothesis has been made that certain peculiarities in linkage of characters may be associated with peculiarities in the behavior of the parts within single chromosomes. If you will pardon my digression into this field I will elaborate the last step. According to the view that the chromosomes are the bearers of the hereditary factors it seemed clear that the factors located in a single chromosome must always go together and a corresponding linkage of adult characters in four groups corresponding to the number of chromosomes was made out for the fruit fly, *Drosophila*. But it was then discovered that the linkage was not complete. Occasional separation took place and the percentage of such separations was found to be definite for any two characters of such a linked group. Still further it was shown that knowing the percentage of such breakings of the linkage between characters A and B and between B and C the percentage of breaking of linkage between A and C could be calculated. It was either the sum or the difference between the first two cases. On this basis the factors in a linked group were arrayed in a linear series in which the actual breaking of linkage between any two points closely followed the expectation. Such a series was extremely interesting and the elaboration and perfection of the series in the various groups of plants and animals in itself would have furnished endless opportunity for research. But the interest in the series was immediately greatly stimulated by the suggestion that these phenomena of inheritance of adult characters could be explained by certain peculiarities in the behavior of the chromosomes. By this suggestion the fields of experimental breeding and of cytology were again brought into connection and there is gradually developing a fruitful hypothesis which in some respects bears the same relation to heredity that the atomic theory does to chemistry. Even if the direct hypothesis proves to be premature it will have been the means of opening up lines of research which otherwise would have remained untouched.

I have taken the time to give this example from the field of biology in order to emphasize my point in urging you to encourage any tendency you may have toward visions of relationship between things that at first seem to be wholly different. Young investigators are often inclined to think when an idea comes to them that it can not be of value because no one else has ever followed it up. Besides I have heard it said that it is one of the functions of a teacher of graduate students to see that they do not waste their time following up unprofitable ideas of their own. This would be very well but for the unfortunate consideration that to many, only well-established ideas are profitable, and therefore new ideas are always considered as unprofitable. This is stand-patism in science and the stand-patter in this field should have even less sympathy than the stand-patter in politics. Our salvation as original investigators depends upon the development of our own ideas. The question may be raised whether it is ever unprofitable for a person to follow out his own ideas. Is it not of more value to us personally to follow up an idea of our own even if it be wrong than it is to prove the truth of a dozen ideas suggested to us by others? But, *your* idea is not necessarily wrong and the fact that it is your own makes it extremely valuable. As your own it enables you to draw on the fund of extra energy which we all possess but which only a personal, living interest can draw out. Only such ideas, to use the words of our

constitution, can make us true "companions in *zealous* research." But beware lest you become so zealous as to forget that theses must be typewritten in a perfectly definite manner in order to be acceptable.

As to procedure in discovering what we call truth, I wish to describe two opposing methods, overdrawing the point at first in order to make the notion clear.

We may decide to investigate some problem that has been called to our attention and may start out to collect all the ideas of previous workers on the subject, to study completely all the facts which others have collected and to study also their attempts at explanation. Then follows a critical analysis of the facts and ideas to see if they are satisfactory and if not satisfactory the lines along which further evidence is desired. Then we proceed to the investigation of those points which seem to us to be necessary for completing the ideas disclosed in the literature of the subject. This method is one generally taught to young investigators but it has certain defects which are not so generally recognized. It puts the investigator in the position of patching up a structure that some one else has built. Nothing is more certain than that in building up a system by which to explain phenomena we at once focus our attention upon certain phases of those phenomena to the exclusion of others. Following this procedure a student of human embryology a hundred and fifty years ago, studying carefully what others had written on the subject, would have had his mind focused on the attempt to see in the egg or spermatozoon the miniature individual with all the mature parts in proper proportion; for according to the view then prevailing either the egg or the spermatozoon must contain such a miniature man. The chances are that he would believe that the problem to be solved is, whether the miniature man is in one or the other, and judging by the experience we have in our beginning biology classes he would have seen it. We have some marvelous figures in the publications of the seventeenth and eighteenth centuries of miniature men all nicely coiled up in the head of the spermatozoon and on the basis of such a figure who could believe that the egg is other than a medium for the proper nourishment and protection of the unfolding man. Especially was this likely to be the case in an age when all things feminine were considered inferior to things masculine. But even in those days there were feminists, for one group of investigators held that the miniature man was in the ovum and that the spermatozoon merely filled the compartively unimportant rôle of a stimulating agent which started the unfolding process of the ovum.

One danger then in this procedure is that it concentrates our attention upon certain phases of phenomena and upon certain ideas concerning them. Even the procedure of definition of terms, while necessary for progress in science has the very evil effect of concentrating the attention upon certain features of a process to the exclusion of others.

It has become the custom in certain graduate schools to put the student through a preliminary training for research on the theory that he ought to obtain a certain familiarity with the ideas of others before he begins to have any of his own. He is supposed to be unfit for any original investigation until he has had his fill of the prevailing explanations. I am inclined to object very strenuously to this program. To my mind it is all important that the personal relation between the investigator and the phenomena he is to study should remain unbroken. There should be allowance in any program of study for some fraction of the time when there may be companionship between the investigator and the phenomena of nature without the presence of a chaperon. It is not at the beginning of an investigation that a person needs to know everything that has been thought by others concerning the problem. Of course, it is all important that before imposing his ideas upon the world he should have tested them fully by comparison with all that others have done. It is to the neglect of the factor of personal reaction that we owe so much of the dead timber among would-be investigators. It is for this reason that we so rarely tap the fires of enthusiasm, that we do not unloose the reserves of energy,

which are waiting to be put into action. Enthusiasm is lost before there is a fair start in investigation. When enthusiasm is lost everything is lost, and the graduate schools are all too full of persons who are carrying out researches as a matter of duty and not as a matter of personal inward necessity.

No one can be a "zealous" investigator unless the investigation of some particular problem is absolutely necessary for his comfort, unless he is unhappy if not at work on it, unless there is an inner flame which will not let him rest. Such an attitude of mind can be obtained only by continued contact with natural phenomena, by a realization of the kinship with nature which makes us carry the joy of companionship from the realm of human beings to all nature whether living or non-living. We know the man who is interested in his fellow-men because he wishes to use them for financial gain. We do not wish to follow his example. The same type of man is to be found in science, the man who sees in nature only a means for obtaining material gain. The true type of investigator, however, is he who delights in the existence of a universe which yields secrets to his tender regard. I remember when I was a boy our neighbors used to bring their sickly house plants to my mother to keep for them until they regained full vigor. When asked why they did so well for her she always said, "They grow so well for me because I love them."

So let me urge upon you the cultivation of a relationship with nature and its problems based upon direct and personal intimate contact with it. The problems you are engaged in solving then become your own problems, their solution becomes necessary for your happiness. Your soul can not have peace until they are solved. CHARLES ZELENY

SCIENTIFIC EVENTS

AMERICAN ASTRONOMY[1]

IN the year 1840 the Dana House Observatory of Harvard College was established by the aid of public funds and private subscription, with William Cranch Bond as director. It was not the first college observatory in America, and other eminent American astronomers had lived earlier in the century, but the date may be taken as the beginning of systematic astronomical observation in the western continent. The U. S. Naval Observatory was established in 1844, and the present Harvard Observatory founded, largely by generous help from private benefactors, in 1846. Other institutions of the period might be named where the science of astronomy of position was pursued, and this, with the splendid work on planets, satellites, comets, asteroids, nebulæ and the astronomy of the solar system generally done at Harvard by W. C. Bond and G. P. Bond, and afterwards by Winlock, is to be considered representative of the astronomy of the United States in the succeeding forty years. The accession of the late Professor E. C. Pickering to the directorate of the Harvard Observatory in 1877 marks the beginning of the astronomical era in which we now live. Spectroscopy, stellar physics, and stellar statistics are the principal features. Professor Pickering's work was stellar photometry on a wholesale scale. Stellar spectroscopy and the determination of the radial velocity of stars by its means had been begun by Huggins in 1864; the photographic plate came into general use as an adjunct to the astronomer's equipment in the decade 1880–90, and these three items have formed the basis of the work of the American observatories of recent creation. The Lick Observatory, with the 36-inch telescope, was completed in 1887 at the expense, as every one knows, of an American business man. The Yerkes Observatory came into existence in 1897, and the observatory at Mount Wilson in 1904. These things are recalled at this moment because, during the past week, English astronomers have been gratified by a visit from a delegation of astronomers from across the Atlantic who were on their way to take part in the establishment of an International Astronomical Union at a conference now being held in Brussels (July 18–28).

At a meeting of the Royal Astronomical Society on July 11, specially arranged for the purpose, the visitors spoke in turn of the work

[1] From *Nature*.

on which they are each engaged, and the contrast between the astronomy of to-day and of sixty years ago is apparent. The absolute magnitude of a star or its actual luminosity independent of its distance is now a commonplace and forms the subject of many investigations. Certain peculiarities of spectrum have been correlated with the absolute magnitude in cases in which the latter is known, and, generalizing from this, a method has been devised for finding from the spectrum the absolute magnitude, and therefore the parallax, of stars. Professor W. S. Adams, to whom this conception is due, was constrained to say that the data on which his first list of parallaxes was based are capable of improvement, but this research is as yet in its early stages. Dr. Seares, also of Mount Wilson, has devised new photographic methods for determining the colors of stars, and a correlation between color, spectral type and absolute magnitude is being established. Professor Benjamin Boss, of the Dudley Observatory, whose name is associated more with geometrical astronomy than with physical, had some interesting facts to tell about the difference in direction of motion of the classes of stars known as the Giant and Dwarf, which is a distinction depending on luminosity.

Dr. Schlesinger, of Allegheny, and Professor Joel Stebbins gave details of their work in determining the variation of brightness of variable stars, the method of the photo-electric cell used by the latter being a very recent adaptation of physics to astronomy not unknown in England; whilst Professor Campbell, director of Lick Observatory and president of the delegation, refrained from speaking of his well-known observations of radial velocity, but told his audience of the observations of the Lick Observatory party on the occasion of the eclipse of June 8, 1918. An attempt was made to detect the Einstein effect, or a light-displacement effect from any cause, by comparison of a photograph of the stars round the sun with a photograph of the same field in the night sky, but the comparison failed to show any displacement of this nature. It is regrettable that the Harvard Observatory was not represented owing to the recent death of Professor E. C. Pickering.

This brief sketch of the proceedings at this meeting is sufficient to show the trend of modern astronomy. It was impressing to see so many men, comparatively young, who are devoting themselves to abstract science. That there is similar progress on this side of the Atlantic reference to recent volumes of the Monthly Notices will show. Here, as counterpart to the brilliant invention of new methods of attack by observation above recorded, we have development by mathematical theory and the statistical discussion of results.

ORGANIZATION OF THE AMERICAN METEOROLOGICAL SOCIETY

An American meteorological society is being formed and will be definitely organized at the A. A. A. S. meeting in St. Louis next December.

The *purpose* of this society is to fill the need for an easy interchange of ideas among those interested in atmospheric phenomena and their effects on man, and thereby to promote instruction and research in these important subjects. There never has been a national association in this large field in America.

The accomplishment of these objects may be brought about (1) by general meetings with the A. A. A. S., and local meetings at other times; (2) by using the *Monthly Weather Review*, the only meteorological magazine of the United States, as a medium for publishing meteorological and climatological articles, and (3) by issuing a monthly leaflet containing news, announcements, notes, and queries.

The principal sources of membership will be, teachers of meteorology (about 200), Weather Bureau employees (around 300), former Signal Corps and Navy meteorologists (nearly 600), and the numerous corps of amateur meteorologists. Dues of $1 a year should be sufficient to cover all expenses of the monthly leaflet and arrangements for meetings.

The need for considerable meteorological work in connection with military and naval operations during the war and our present expanding demands for weather forecasts not only at the surface but also at various levels in the free air makes the present the opportune time to capitalize the war-time interest

as a foundation for the great future needs of meteorology. I would be glad to have communications from prospective members of a meteorological society in order to have a strong, tentative organization and working plans for the formal establishment of this society.

CHARLES F. BROOKS

WEATHER BUREAU,
WASHINGTON, D. C.

SCIENTIFIC NOTES AND NEWS

AT the recent meeting of the American Academy of Arts and Sciences Professor Forest Ray Moulton, of the department of astronomy and astrophysics of the University of Chicago, was elected a fellow in the section of mathematics and astronomy.

AT the recent commencement exercises of the University of Georgia, Augusta, the honorary degree of doctor of science was conferred on Dr. John M. T. Finney, of Baltimore.

QUEEN'S UNIVERSITY, Belfast, has conferred the degree of LL.D. on Lieutenant-Colonel Ribert McCarrison, I.M.S., a graduate of the university, in recognition of his investigations into the causes of goiter and cretinism; on Dr. Johnson Symington, for twenty years professor of anatomy in the university, and now emeritus professor; the D.Sc. on Sir David Semple, late R.A.M.C., a medical graduate of the university, formerly assistant of pathology in the Army Medical School, Netley, and director of the Pasteur Institute, India; the M.D. on Professor J. G. Adami, F.R.S., vice-chancellor of the University of Liverpool, and lately professor of pathology in McGill University, Montreal, in recognition of his researches in pathology; on Dr. Alexis Carrel, member of the Rockefeller Institute of Experimental Medicine, New York, and during the war medical officer of the Special Research Hospital of the French Army; on Professor Harvey Cushing, of Harvard University; on Lieutenant-Colonel J. A. Sinton, V.C., I.M.S., formerly Riddell demonstrator in pathology at Queen's University, in recognition of his early distinctions and of his valor in the field while engaged in the treatment and succor of the wounded.

THE Navy Department announces the promotion of the following officers of the Medical Corps, Reserve Force, to the rank of commander; William Seaman Bainbridge, Robert Crier LeConte, William Baret Brinsmade, Stanley Stillman, Eugene Floyd DuBois, Rea Smith, John Chalmers DaCosta, Milton Joseph Rosenau, George Gorgas Ross, Albion Walter Hewlett, Hobart Amory Hare, Robert Battery Greenough, Judson Deland, James Eli Talley, Edward Milton Foote, Paul Adin Lewis, Guy Cochran, Verne Adams Dodd, Edgerton Lafayette Crispin, John Aloysius McGlinn, LeRoy Goddard Crandon, Harold Denman Meeker, Nelson Henry Clark, Halsey DeWolf, Charles W. Moots, George Arnold Matteson, James Taylor Hanan, Francis Joseph Dever, Frank Cousins Gregg, Clifford Elmore Henry, Porter Bruce Brockway, Clinton C. Tyrrell, Frederick Obadiah Williams, Harvey Mitchell Righter, Zachray Thomas Scott, William Curtis Newton, William Henry Areson. This is the first time in the history of the Navy that medical reserve officers have been ranked higher than Lieutenant Commander.

R. F. BACON, A. V. Bleininger, G. A. Burrell, F. G. Cottrell, J. O. Handy, G. A. Hulett, G. F. Mason, Samuel R. Scholes and Alexander Silverman have been appointed delegates from the American Chemical Society to attend the ceremonies, exhibits and demonstrations to be given at Pittsburgh, Pa., September 29–30 and October 1 at the time of the dedication of the new buildings of the Bureau of Mines.

DR. JACK J. HINMAN, JR., after having been on leave of absence as a captain of the Sanitary Corps in the A. E. F., engaged in water supply work, has returned to his work as water bacteriologist and chemist for the Iowa State Board of Health, and assistant professor of epidemiology in the State University of Iowa.

DR. EDWARD G. BIRGE has been appointed state epidemiologist of Iowa, succeeding Dr. John H. Hamilton, Iowa City. Dr. Birge is the son of President Birge of the University of Wisconsin.

Dr. Samuel T. Orton, of the University of Pennsylvania Hospital, has been appointed head of the Psychopathic Hospital of the University of Iowa, Iowa City.

The field party of the New York State College of Forestry, at Syracuse, has begun its second season of field work on the cooperative ecological survey of the Palisades Interstate Park. The field party, under the direction of Dr. Charles C. Adams, representing the College, and Mr. Edward F. Brown, representing the park, consists of Professor P. M. Silloway, who is continuing his study of bird tramping trails, in cooperation with Professor H. R. Francis, who is studying the general problem of park trails. The park fishes are being studied by Professor T. L. Hankinson, Dr. Adams and Dr. W. C. Kendall, in cooperation with the U. S. Bureau of Fisheries. Dr. J. Percy Moore, also working in cooperation with the Bureau of Fisheries, is studying the control of mosquitoes by fish. He is also making a study of the control of leeches. Mr. Walter H. Rich is making fish portraits and Mr. Edmund J. Sawyer those of birds. The field assistants of the party are Mr. Robert K. Fletcher and Mr. Winn Merrill. This cooperative survey is conducted by the College of Forestry, the Commissioners of the Palisades Interstate Park, and in part by the United States Bureau of Fisheries.

"Mathematics and Statistics" is the subject of the retiring address of the president of the Mathematical Association of America, Professor E. V. Huntington, Harvard University, to be given at Ann Arbor on September 4.

A campaign committee has made plans for raising funds for the erection of an Abraham Jacobi Memorial Hospital for Washington Heights, New York City. This locality has been chosen because of its lack of hospital facilities. The active campaign will not be begun until November. Dr. S. Robert Schultz is executive director of the campaign and has issued a call for volunteer workers. A resolution will be introduced in the board of aldermen at the first fall meeting, proclaiming Heights Hospital Week from November 15 to 22.

Appropriate exercises at the unveiling of the memorial tablet to the late Dr. Charles O. Zahner, professor of physiology in the University of Louisville, took place in the college building, June 26.

UNIVERSITY AND EDUCATIONAL NEWS

Dr. Bradley M. Davis, of the University of Pennsylvania, has been appointed professor of botany at the University of Michigan. He will take up his new work in October.

Arthur H. Blanchard has been appointed professor of highway engineering at the University of Michigan to occupy the chair recently established by the board of regents. He will retain his consulting office at Broadway and 117th Street, New York City, until September 15, after which he will be at Ann Arbor, Michigan.

Dr. Arthur C. Neisch, of Columbia University, has accepted a position as head of the department of chemistry at Queen's University, Kingston, Ontario.

Messrs. Frederick S. Dellenbaugh, Arthur L. Nelson and F. B. Philbrick, have been appointed instructors in electrical engineering at the Massachusetts Institute of Technology. Mr. Dellenbaugh was a captain of the Signal Corps in overseas service during the war. During the war Mr. Nelson was a lieutenant in the Engineer Corps of the Navy with important work relating to construction of power plants and supply of power at the submarine base.

Mr. E. A. Wildman has resigned his position as director of chemical research for Eli Lilly and Company, and has accepted the position of professor of chemistry and director of the chemical department of Earlham College.

Professor A. Findlay, of University College of Wales, Aberystwyth, has been appointed to the chair of chemistry in the University of Aberdeen in succession to Professor Soddy who has accepted a call to the University of Oxford.

THE University of Bristol has made the following appointments to the professorial chairs mentioned: *Botany:* Dr. Otto Vernon Darbishire, lecturer in botany in the university. *Education:* Dr. Helen Marion Wodehouse, principal of the Bingley Training College, Yorkshire. *Henry Overton Wills Chair of Mathematics:* Dr. H. Ronald Hassé, late fellow of St. John's College, Cambridge; senior lecturer in mathematics in the University of Manchester. *Mechanical Engineering:* Major Andrew Robertson. *Henry Overton Wills Chair of Physics:* Dr. Arthur Mannering Tyndall, acting head of the department of physics in the university during the war. *Henry Overton Wills Chair of Physiology:* Dr. George A. Buckmaster, assistant professor of physiology in the University of London.

DISCUSSION AND CORRESPONDENCE

TANDLER AND KELLER ON THE FREE-MARTIN[1]

IN April, 1916, the writer published a short article on "The Theory of the Free-Martin"[2] in which he sought to demonstrate that contrary to the then prevailing opinion the free-martin is a female, and that its intersexual condition is due to early embryonic anastomosis of the blood vessels of its chorion with those of the male twin, with consequent inversion, more or less complete, of the internal organs of reproduction by action of the testicular homones of the male. A detailed account of the data and theory was published in the *Journal of Experimental Zoology* in 1917.[3] At the time of publication the writer supposed that both the data and theory were new, but he has learned this summer by a reference in a work of Magnusson[4] that some of the data at least were anticipated by Tandler and Keller in a publication dating from 1911.[5]

These writers studied seventeen pairs of two-sexed cattle twins in fœtal stages and determined the following fundamental facts:

1. That such twins have a common chorion.

2. That branches of the umbilical vessels, especially the arteries, anastomose by relatively large branches, so that an injection from an umbilical artery of one fœtus would pass over into the umbilical arteries of the other. The females of such pairs possessed the typical "hypoplastic genitals" of the free-martin.

3. In one case, in which there was no macroscopic vascular anastomosis in the chorion and the injection would not pass over, both male and female possessed normal reproductive organs. The authors consider this more than a mere matter of chance.

4. That the maternal ovaries possess two corpora lutea, usually one in each ovary; hence they correctly interpret the twins as dizygotic.

5. The youngest pair of twins examined had a neck-rump measurement of 21 cm.; the female was typically malformed. Hence the origin of the condition is earlier.

From these facts the authors conclude that "vascular relationships and genital development stand in some kind of etiological relationship."

The writer independently stated all of these facts in his 1916 paper, and in addition the following facts and considerations:

1. A comparison of sex ratios of the four kinds of twins ♂♂, ♀♀, ♂♀, ♂♀, demonstrating from the statistics that the sterile free-martin must be zygotically female.

2. A study of much earlier stages than the youngest of Tandler and Keller showing that the union of chorions is secondary and that it probably occurs at or about the time of beginning sex-differentiation (20–25 mm.).

3. A statement of conditions of the fœtal membranes in twins of sheep, showing that, though the membranes fuse, no macroscopic

[1] To the kindness of Professor A. Lipschütz, of Berne, the writer owes a reference to a later and presumably more complete account of the investigations of the same authors (*Wiener Tierärzlitche Wochenschrift*, III., Jahrgang, Heft 12, 1916), which however he has not yet seen.

[2] SCIENCE, N. S., XLIII., pp. 611–613.

[3] Vol. 23, pp. 371–452.

[4] *Arch. f. Anat. u. Physiol., Anat. Abt.*, 1918, pp. 29–62.

[5] *Deutsche tierärztliche Wochenschrift*, 19 Jahrgang, 1911, pp. 148–149.

vascular anastomosis develops and the female of two-sexed pairs is normal.

4. A brief description of some of the outstanding features of the anatomy of the reproductive system of fœtal free-martins.

5. A complete statement of the homone theory.

The writer regrets that he should have overlooked such an important contribution as that of Tandler and Keller. Its publication in a journal practically unknown to American biologists, and the fact that no reference to it was found in any of the other literature on the subject until after the war explains the occurrence. The writer's interest in the subject arose originally from the birth of free-martins in his own herd of cattle (from 1909 on); thus brought into immediate contact with the subject he realized its great biological significance and first took up its serious study in 1914. Proximity to the Chicago stockyards from which material could be secured in abundance was another inciting cause to its study.

The main, and very satisfactory, feature of the situation is, however, that the fundamental facts have now been determined from two entirely independent series of investigations, at least to the extent indicated, and that all doubt as to the general cause of this remarkable phenomena must consequently vanish.

Frank R. Lillie
University of Chicago

THE ANTISCORBUTIC PROPERTIES OF RAW LEAN BEEF

Recent publications of Chick and Hume, Hess and Unger, Givens and Mendel, Cohen and Mendel, Harden and Zilva and others have contributed much to our knowledge of the etiology of scurvy and the antiscorbutic properties of food materials. It is quite generally agreed that normal development and well-being in animals are dependent upon certain accessory food factors, known as vitamines, of which there are, at present, three types: (*a*) fat-soluble A, a growth-promoting vitamine, the absence of which produces xerophthalmia and possibly other pathological conditions, (*b*) water-soluble B, a growth-promoting vitamine, the absence of which produces polyneuritis, and (*c*) the antiscorbutic substance, found in certain food materials, which Drummond[1] has named "water-soluble C."

Stefansson[2] in observing three cases of scurvy in his polar expedition, states that meat, and especially raw meat, prevented and cured scurvy while those of the party who subsisted, from choice, on carbohydrates, casein, cereals and a small amount of cooked meat, became afflicted with the disease.

This is not in agreement with the work of Chick, Hume and Skelton[3] or Pitz[4] for the former were unable to prevent the onset of the disease (in guinea pigs) by the administration of meat juice, while the latter made the same observation except that the administration of dry meat to the oats-milk diet delayed the onset of symptoms. Pitz attributes this to the better plane of protein intake, but we are inclined to believe that this is not the case, for he states that milk was fed *ad libitum* and it is generally agreed that the antiscorbutic properties of milk are proportional to the amount of milk ingested. We are also of the belief that those animals, described by Pitz, which showed improvement when fed meat and salt mixtures, drank more milk on account of the stimulation of thirst, with the result that the symptoms were delayed due to the increased amount of milk ingested.

We have found that, not only must the amount of milk fed in experimental scurvy be carefully controlled, but the diet of the cow is also a very important factor. We shall soon publish data to show that guinea pigs fed on oats and 20 c.c. of "spring milk" (daily) from cows fed on green grass and a

[1] Drummond, J. C., *Lancet* (Lond.), CXCV., No. 4963, No. XV. of Vol. II., p. 482, 1918.

[2] Stefansson, V., *J. Am. Med. Assn.*, Vol. 71, No. 21, p. 1715, 1918.

[3] Chick, H., Hume, E. M., and Skeleton, R. F., *Biochem. J.*, Vol. XII., Nos. 1 and 2, p. 136, 1918.

[4] Pitz, W., *J. Biol. Chem.*, Vol. XXXVI., p. 439, 1918.

grain ration, develop scurvy later, do not as a rule lose in weight, but on the contrary often gain in weight, live considerably longer and are in a much better physical condition, with the exception that scurvy usually develops, than those animals receiving 25 c.c. of milk from cows on a winter ration of ground oats, corn and barley, corn silage and alfalfa hay. We attribute this, tentatively, to the increased amount of fat soluble A in the "green grass" milk. We are now conducting experiments to ascertain the nature of this growth promoting substance.

In this preliminary paper we wish to state that our experimental work indicates, quite conclusively, that raw, lean beef does not possess antiscorbutic properties, so far as those properties can be tested by observations on guinea pigs. We have fed a cold water extract of meat representing 5, 10, 15 and 20 grams of meat, respectively, to guinea pigs receiving a basal diet of oats (ad libitum) and 25 c.c. of autoclaved milk. In all cases the guinea pigs developed scurvy just as soon as those animals which received nothing but oats and milk. When 5 c.c. of orange juice (daily) were added to the oats-milk diet and to the oats-milk-meat extract diet, all animals grew normally and no scurvy developed. We have not depended upon external symptoms and autopsies, solely, but have substantiated our findings by histological examination of the bones.

Owing to the fact that the guinea pig is a herbivorous animal, we have experienced some difficulty in being able to feed definite quantities of solid raw meat. By incorporating finely chopped meat into dry, rolled oats we have been able to show that scurvy will develop in practically the same time as when the meat extract was fed.

The experimental data will be published in the near future.

R. ADAMS DUTCHER,
EDITH M. PIERSON,
ALICE BIESTER
SECTION OF ANIMAL NUTRITION,
DIV. OF AGR. BIOCHEM. AND
DIV. OF HOME ECONOMICS,
UNIVERSITY OF MINNESOTA

AURORAL DISPLAYS

FOLLOWING a faint arch which was visible between 9 and 10 P.M. (75th mer. time), August 10, a crimson aurora extending over the northern sky and up to the magnetic zenith was observed here just before dawn, August 11, 1919. At 3:50 A.M. I noticed through the haze a curtain-like arch with a changing base which averaged about 15° above the horizon in the north, and with ends fading out in the east and west. At 4:00 A.M. a large portion of the western sky above 20° altitude became lighted with a vivid crimson glow. This coloring spread east above the whitish arch on the north until from 4:05 to 4:10 most of the northern sky from the zenith down to an altitude of about 25° was covered with it. The time of greatest brilliance was at 4:05 A.M., when whitish streamers were sharply defined in an arch which crossed the meridian between pole-star and zenith. These streamers converged at the magnetic zenith and formed a faint northern half of the auroral corona. After 4:15 the light of dawn augmenting that of the full moon dimmed the aurora till at 4:25 its last faint shafts of light were fading.

Whitish streamers were visible again at 8:35 P.M. about 50–60° up in the north, and for a little while there was a faint suggestion of an auroral arch: but the cirrus clouds, dense haze and full moon prevented further discernment of this display.

CHARLES F. BROOKS
CHEVY CHASE,
WASHINGTON, D. C.

AN unusual demonstration of the Aurora Borealis occurred at Ogunquit, Maine, on the night of August 11. The lights began at about 9:40 P.M. with the appearance of long, thin cloudlike masses extending horizontally a little west of north and about 25° above the horizon. This almost at once passed into curtain masses to the east, which remained less than ten minutes. The next (third) phase began by the sudden shooting up from the lower cloudlike masses of the long ribs of streak light which extended clear to the zenith.

These long vertical shoots of light presently extending around half the horizon, forming what was the most noted feature of the display for this locality; that is the continuity and great extent simultaneously over the heavens of masses of shafts of aurora half way about the horizon and up to the zenith where the light shafts met in a great cloud which momentarily shifted its form and extent.

Chromatic effects noted were pale rose pink and a delicate apple green. These were distributed apparently in local spots the green to east. A brilliant full moon added an unusual feature to the display. The lights faded suddenly about 10:15 P.M. and locally were not reported as of any moment later than that.

Aurora is not rare at this locality in August but this is the most extended demonstration seen by me here in some years.

Frederick Ehrenfeld

Ogunquit, Maine

I was very much interested in the descriptions of the auroral display of May 2, published in Science for May 23, and especially so in that of Mr. G. Irving Gavett, as it seems that I saw here in Washington, D. C., the same display that he saw in Washington state and at about the same time. I was observing with the photographic zenith tube of the U. S. Naval Observatory on that evening and entered a note, at about $12^h\ 0^m$ Washington sidereal time ($14^h\ 27^m$ G. M. T.). The display at this time did not strike me as unusual except in the brightness of the illumination. There was the usual northern arch and streamers and at one time, of which I made no note, a patch of very deep red in the northwest.

At $13^h\ 43^m$ Washington sidereal time, I first saw what was to me a very peculiar display. A band of light as broad as the Milky Way, but much brighter, extended from a point on the western horizon about ten degrees south of Pollux, passed just north of the Sickle in Leo, over Alpha Canum Vaneticorum and Corona Borealis and faded out on the eastern horizon about ten degrees south of Altair. It seemed nearly twice as broad at the meridian as at the horizon. The lights of the city illuminate the southeastern horizon considerably and the intensity did not appear as great there as at the zenith, nor did it seem as bright at the zenith as in the west. I made the note "bright as an army searchlight at $13^h\ 43^m$" for this part of it. It faded very rapidly until at $14^h\ 0^m$ Washington sidereal time it was "just discernible" in the west. But it brightened up again and at $14^h\ 15^m$ was as bright as the Milky Way in Cygnus on a very clear night and "traceable to the zenith." The band was broken into two parts between thirty and forty-five degrees from the horizon by a dark lane about one degree wide inclined at an angle of about fifteen degrees to the line of light and presented much the same appearance as the Milky Way in Cygnus in this respect also. The greatest intensity in this second maximum occurred at about $14^h\ 30^m$. The light at this time seemed to pulsate slightly after the fashion of some streamers from the northern arch. This was not pronounced, however.

During the whole display the position of the band remained practically constant. A slight change in the position of the band with respect to the Sickle in Leo was noted but this was attributed to the motion of the stars themselves as they were setting, the shift of the band being southward. I do not recall the appearance of the northern sky at the time of this display. If there was aurora there it was not prominent.

In *Popular Astronomy* (Vol. XXVII., p. 405), Mr. William H. Wagner describes the same phenomenon as seen from West Reading, Pa. From his description and by the use of a celestial globe I estimated that its parallax as seen from the two places amounted to very nearly twenty degrees. West Reading, Pa., is roughly one degree five minutes east and one degree twenty-five minutes north of Washington, D. C. From a consideration of this data, which is inherently approximate, I deduce an altitude of 275 miles above the earth's surface for the beam of light. Its width from north to south then was about 60 miles, and if it was continuous between here and Seattle, Wash-

ington, where Mr. Gavett saw it, it must have been nearly 2,500 miles long.

WM. A. CONRAD
U. S. NAVAL OBSERVATORY,
WASHINGTON, D. C.

MONKEYS AS COCONUT PICKERS

E. W. GUDGER has recently called attention in SCIENCE to the use of monkeys as coconut pickers. The Malays and Bataks of Sumatra very commonly use monkeys in this way. The current English name there for the monkeys, *Macacus Nemestrinus,* is "coconut-monkey." The work of picking the nuts is performed in a way essentially the same as that described by Shelford and quoted by Gudger.

These monkeys not only work, but have a considerable commercial value as laborers. The price of a trained coconut monkey ranges from about $8.00 to $20.00; a price far above that put upon other common sorts of monkeys which are kept only as pets.

Coconut monkeys grow to a considerable size, and are very strong. They are also, usually savage, and will inflict a nasty bite whenever they have a chance.

CARL D. LA RUE
KISARAN, ASAHAN, SUMATRA

SCIENTIFIC BOOKS

Vital Statistics: An Introduction to the Science of Demography. By GEORGE CHANDLER WHIPPLE. New York, John Wiley and Sons. 1919. Pp. 517. $4.00 net.

Vital statistics have developed slowly in the United States. In spite of much progress in recent years, official records, including federal, state and municipal, still lack much in extent of the field covered and in detail of treatment. A nation-wide registration area for the recording and analysis of the elementary vital phenomena of birth and death is still unattained. A number of states and many of our cities of good size and of undoubted prosperity and economic development make no serious effort to collect the facts of their vital resources. It is no wonder then that we, in America, have lacked adequate text-books and competent teachers for the instruction of those interested in the science of vital statistics. Physicians who would profit most from knowledge of the subject receive virtually no instruction in this science. Health officers, in like manner, have only, within the last few years, awakened to the value of vital statistics as a mechanism in their work and only a few are competent to use it effectively.

Professor Whipple's book will, therefore, help to fill a long felt want. It is, frankly, a book for health officers. It is not intended for advanced students as a contribution to the method of statistics. It is rather a guide to those who would be familiar with the simplest methods as applied to the public health field. Only Dr. Newsholme's volume on vital statistics (now out of print) has been available for English readers during the last three decades. The present book, perhaps altogether more attractive in its mode of approach, will now serve American students and will present recent, often current, data concerning their own country.

The book may be divided into two parts; the first covers the technique of practical statistics, the second discusses the phases of vital phenomena of populations. The appendices give a rather incomplete bibliography, the model law for reporting diseases, births and deaths and logarithms of numbers up to 10,000.

The first section, pages one to ninety-nine, is a useful first aid to the student of the methods of crude statistical description. The usual devices and methods are described clearly and even pleasingly. This is obviously Professor Whipple's *forte.* He, as a sanitary engineer, has given proper place in his own writings to the graphic methods and to other attractive means of clear presentation of statistical materials. The student will, however, unless he carries his studies much further than the text, find himself only at the threshold of statistical method after he has covered this first part. Perhaps this is all that is intended by the author, who assumes no special mathematical skill or equipment on the part of his students. This section would ordinarily have given the greatest

difficulty in presentation. Professor Whipple has made it an attractive group of chapters, well written and even interesting.

Pages 100 to 458 are, in effect, a discussion of American demography. The chapters cover the methods of enumeration and registration; the characteristics of population; death rates, birth rates and marriage rates; specific death rates; causes of death, with especial reference to particular diseases and for specific age periods. Three chapters entitled, Probability, Correlation and A Commencement Chapter close this section of the book.

The elementary facts of the vital statistics of the United States are clearly presented in the above chapters. In fact, the author makes a special effort to hold his reader by simplicity, clearness and force of statement. Professor Whipple's book will not prove a difficult one for the student. It does not attempt too much along lines of thoroughness of treatment. Only the high spots are touched. Therein lies its value and perhaps also its danger. For while this book will undoubtedly increase the skill of the health officers in the presentation of their reports, it may also give many a feeling of competence greater than is justified by their skill. One would have wished that tuberculosis, cancer and a few other of the more important diseases had been treated more thoroughly in the light of recent contributions on these diseases. These could then have served as general models for the discussion of diseases as causes of sickness and death. In fact, the author has paid too little attention to the very important subject of the classification of the causes of death. This should be a vital matter to all health officers if they are to publish accurate statistics of the mortality of their respective communities. It is also characteristic of this book that the discussions are somewhat disjointed, perhaps because of the desire of the author not to overstrain the attention of the reader. We often find a subject treated in a number of places where a more continuous discussion would have left a clearer impression.

Altogether, this is a useful first course which, under competent laboratory instruction, should add materially to the popularity of vital statistics among health officers and others engaged in developing the public health movement in the United States. Professor Whipple will have earned the gratitude of those engaged in public health work if the book does what is hoped for it. This may be some compensation for the time which he, as a busy sanitarian, must have taken from his work in order to have made this text-book possible.

Louis I. Dublin

1 Madison Avenue,
New York City

A HISTORICAL NOTE ON THE SYNCHRONOUS FLASHING OF FIREFLIES

The interesting accounts of this remarkable habit published in Science during the past two years by Professor E. S. Morse and others have led me to make notes of similar accounts found in working up certain books on the East Indies and New Guinea. The excellent summary of our knowledge of this striking phenomenon published in Science for July 26, 1918, by Professor Morse, and the later communication from Mr. George H. Hudson led me to believe that these historical data may be of interest and possible value to those studying this habit in insects.

The first of these accounts was found in Robert W. C. Shelford's book "A Naturalist in Borneo" (London, 1916), a work replete with natural history data of great interest and value. At the time that I made a note of Shelford's observations, I had forgotten that Professor Morse in Science for September 15, 1916, had published Shelford's account from advance proof sheets of his book.

The next account I have chanced upon is from the pen of Nelson Annandale, the well-known zoologist of Calcutta, India. His paper, "Observations on the Habits and Natural Surroundings of Insects," made during the "Skeat Expedition" to the Malay Peninsula, 1899–1900 was published in the *Proceedings of the Zoological Society of London,* 1900.

From Part VI., "Insect Luminosity," the following extract is taken:

Of all the manifestation of luminescence among animals there is none more curious, or, in the present state of our knowledge, more inexplicable, than the manner in which large numbers of individuals of certain fireflies are able to display their light with absolute apparent simultaneity and unison and with regular intervals of darkness, under circumstances which make it impossible for all the members of the swarm to see one another. Even the power, possessed by some peculiar South-American beetles, of showing lights of different colors on different parts of the body at the same time is not more wonderful, or more conspicuous, than this. The phenomenon is not common on the east coast of the Malay Peninsula, where the soil is sandy; but it is said to be often manifested both in Siam proper and among the mangrove-swamps of Perak and Selangor in the west. I have only been able to see it on one occasion, and that was on the bank of the river Kuala Patani, one fine evening at the end of June.

A large tree was covered with many hundreds of fire-flies, the majority of which seemed, judging from the similarity of their lights, to belong to one species, or perhaps to one sex. There were three individuals seated together, however, whose lights were larger and bluer than those of the others. The lights of all the specimens of the more abundant variety flickered in unison with one another; those of the minority, the three individuals, flickered together also, but in a different time. At one instant the tree was all lighted up as if by hundreds of little electric lamps; at the next it was in complete darkness, except for three blue points. Then, again it was covered with white points, except for a little patch of darkness where the three blue points had been, and would be again immediately. A similar power of displaying luminosity in unison is said to be exhibited by some marine animals, even after they have been removed from the water; but the questions as to how this unison is effected and what is its exact object are obscure. The power by which it is regulated may be somewhat analogous to that which causes all the individuals composing a flock of birds to wheel at the same instant. As Professor Poulton has pointed out to me, the rhythmical display of light among a crowd of individuals appears much more conspicuous to the eye than the simple flickering of a number of independent points.

It will be noted first that Annandale's account is very circumstantial, perhaps more detailed than any account yet at hand. Secondly it should be noted that he writes that "it is said to be often manifested both in Siam proper and among the mangrove swamps of Perak and Selangor in the west." In other words this phenomenon is not so unusual in Malaya as might be surmised from its rare occurrence in our country.

Antedating Annandale by twenty years is an account by Burbidge of an excursion on the Scudai River, Jahore (Johore?), near Singapore. He says (1880) that:

The silence of the night was unbroken, save by the regular dip of the oars, and as darkness increased, the tiny lamps of the fireflies became visible here and there among the vegetation on the banks. As we glided onward, their numbers increased, until we came upon them by thousands, evidently attracted by some particular kind of low tree, around which they flashed simultaneously, their scintillating brilliancy being far beyond what I could have imagined to be possible.[1]

Still earlier than Burbidge we may find in Sir John Bowring's "The Kingdom and People of Siam: with a Narrative of the Mission to that Country in 1855":

How can I pass the fireflies in silence? They glance like shooting stars, but brighter and lovelier, through the air, as soon as the sun is set. Their light is intense, and beautiful in color as it is glittering in splendor—now shining, anon extinguished. They have their favorite trees round which they sport in countless multitudes, and produce a magnificent and living illumination; their light blazes and is extinguished by a common sympathy. At one moment every leaf and branch appears decorated with diamond-like fire; and soon there is darkness, to be again succeeded by flashes from innumerable lamps which whirl about in rapid agitation. If stars be the poetry of heaven, earth has nothing more poetic than the tropical firefly.[2]

[1] Burbidge, F. W., "The Gardens of the Sun: or a Naturalist's Sojourn on the Mountains and in the Forests and Swamps of Borneo and the Sulu Archipelago," London, 1880, p. 34.

[2] Bowring went to Siam as minister plenipotentiary to negotiate a treaty of peace and open up a

However, antedating even Bowring, the synchronous flashing of fireflies on the Meinam River had been described by another. In 1690, Engelbert Kaempfer left Batavia as physician to the Dutch Embassy to Japan. For some unexplained reason this embassy went to Nagasaki via Siam, and describing his return down the Meinam River from Bangkok in 1690, Kaempfer wrote:

> The Glowworms (Cicindalæ) represent another shew, which settle on some Trees, like a fiery cloud, with this surprising circumstance, that a whole swarm of these Insects, having taken possession of one Tree, and spread themselves over its branches, sometimes hide their Light all at once, and a moment after make it appear again with the utmost regularity and exactness, as if they were in a perpetual Systole and Diastole.[3]

Another account is taken from John Strachan's "Explorations and Adventures in New Guinea," London, 1888. This account is not strictly in line with that preceding, since it seems to be of synchronous movement rather than flashing, but at any rate it seems worth while to quote Strachan briefly. Of the man and his book no information is at hand. On page 38 he writes of fireflies observed near the Fly River:

> We sat gazing enraptured on a pyramid of living light, suspended, as it were, by threads of fairy gold. On a huge black walnut [?] tree there had gathered myriads of fireflies, which, moving through the dark foliage as if to the time of some enchanter's music, presented a scene of exquisite loveliness, which it is impossible to describe. As the fairy mass revolved, now up, now down, then round as to the measured time of a dance, my companion in ecstasy exclaimed "Captain, I would work twelve months for nothing to see such a sight as this."

The last notice that has come to light is distinctly of synchronous movement but it may not be amiss to quote it here. Burbidge on one of his trips to Kina Balu, the great mountain of Borneo, found the natives of Kalawat, a village near its base, raising bees in hives of hollow tree trunks set under the projecting roofs of their huts. Of these bees, Burbidge says:

> The kind of bee kept is very small, much smaller than that common in England, and I was much struck at the peculiar manner in which they wriggle their bodies simultaneously as they congregated in groups on the hive near the entrance.

The above accounts are those that have been found in the course of reading for other ends, but it is more than likely that a systematic search through large numbers of books of travel in the East Indies would bring to light other accounts. At any rate those given indicate that there is a "literature" even though small of this remarkable phenomenon.

E. W. Gudger
American Museum of Natural History,
New York City

[3] Kaempfer, Engelbert, "The History of Japan with a Description of the Kingdom of Siam," translated by John Caspar Scheuchzer, 2 vols., folio, London, 1727. This is best available to the general reader in the elegant reprint in three volumes of the 1727 edition by James McLehose and Sons, Glasgow, 1906. Our reference is to pages 78–79 of Volume I. of this edition.

SPECIAL ARTICLES

THE ORIGIN OF NERVE CELL PIGMENTS

The determination of the origin of the two recognized pigments of the nerve cell, the melanin and the lipochrome, has equal application to other somatic cells and correlates their normal and abnormal occurrence. The subject is therefore one of general biologic interest.

The melanin pigment is produced by functional depression of some duration in any cells. It has been fully excluded experimentally from normal function and overfunction, and also from the natural senescence which ultimately results from function (senility of excitation). In short, the nerve cell by its specific differentiation is never hampered in its normal processes by the permanent accumulation of waste products of metabolism.

The histogenesis of the melanin is from nuclear material, both intranuclear and the

chromidial apparatus, or the so-called Nissl substance. It is a true metabolic pigment.

The genesis of the melanin in depression explains satisfactorily its occurrence in conditions of frank disease as well as in abnormal physiological conditions. It happens in disease because the majority of abnormal stimuli are essentially depressant. Melanin is also an almost invariable concomitant of old age. Recognizing the dual forms of senility, senility of depression and senility of excitation, the melanin is introduced by depression, which is an almost inevitable factor in the production of the combined state as it occurs in an organism under ordinary conditions. In the separate experimental production, pigment is the most concrete point of difference between the two forms of senility.

Of particular interest to anatomists is the exploding of the tradition that melanin pigment is a natural structural constituent of certain nerve cells. Such old terms as substantia nigra and locus cæruleus apparently have given this idea its greatest plausibility. Also the bulk of human anatomical material is from old or diseased individuals. Still no two investigators have ever agreed, either on its time of development, or on the places of its consistent location. As a matter of fact, the melanin may be entirely absent from an adult nervous system, and even if present in some cells of a part, it may be absent in others. Such pigment-free animals are however scarce, for few have escaped depression. Extending this negative deduction to man, the cells supposed to be pigmented are the most obviously homologous with those of lower animals naturally pigment free, and it would be a most unique anomaly if man's differentiation alone should endow him with the useless.

The lipochrome, or as it has been more commonly designated in doubt of its origin, the fat-holding or fat-combined pigment, has been the object of more active investigation and discussion in recent years. Its characteristic is its reaction to the fat stains, Sudan III. and scarlet red. The prevailing opinions have been either that it is some sort of a by-product of cell metabolism, an "Abnutzung" or "wear-and-tear" pigment, as designated by Lubarsch, or that it is a more specific product of fat or fatty acid metabolism, the lipofuscin of Borst and Hueck.

The lipochrome turns out to be an exogenous pigment derived from the carotinoid pigments, namely, the carotin and xanthophyll of plants, which are ingested with the food.

It might seem surprising that so direct a connection has escaped identification. It has not escaped a surmise, as the original transferrence of the word lipochrome from botany testifies, but the difficulty was that certain of the earlier microchemical tests for lipochrome in plants failed in their application to animal tissues. The development of the chemistry of the pigments is bringing a progressive identification between plants and animals. The identification started with the isolation in crystalline form of xanthophyll from the yolk of the hen's egg and of carotin from the corpus luteum by Willstätter and Escher.

The knowledge of the relation of these pigments to animal metabolism has been extended chiefly by Palmer and Eckles and later by Palmer alone. They have shown that the natural yellow pigment of the milk fat, body fat, corpus luteum and blood serum of the cow is identical with carotin, while xanthophyll predominantly, with some carotin, colors the egg yolk, body fat and blood serum of the hen. Further Palmer has demonstrated a remarkable species difference. Species with colored fat, such as the cow, horse and hen, carry the pigments in the blood serum; species with colorless fat, such as sheep, swine and goats, do not carry the pigments in the blood serum under the most favorable conditions.

Palmer is also carrying on some conclusive feeding experiments on chickens. Chickens deprived from birth of carotinoid pigments show absence of the yellow pigment in their skin, fat, egg yolk and blood serum. Given the pigments in their food, the color is restored. If any fowl, yellow from its natural food, be deprived of pigment, the color fades, though the process takes some months.

Such findings so aptly provided for an intracellular occurrence of lipochrome that the working hypothesis for the nerve cell was based on them. The point that first focused our attention on the probable carotinoid identity of nerve cell lipochrome was its absence in the rabbit and dog. The rabbit and dog have colorless fat. Man and cattle, known to show intracellular lipochrome, have colored fat.

Verification was first sought in the chicken. With the use for the most part of Palmer's chickens above described, two series were run, the one lacking carotinoid containing food from birth, the other carotinoid fed. The carotinoid feeding ranged from a one week's introduction in a bird hitherto carotinoid free to a lifelong natural pigment food in others. In one half of the chickens of both series the factor of depression by heat, phosphorus, morphine or a rice flour diet was introduced to cover the side of disease.

The results were uncomplicated. Both normal and depressed chickens on any carotinoid diet showed the presence of the characteristic yellow pigment in all nerve cells. The carotinoid-free chickens lacked such a pigment in demonstrable amount.

However, this physiological demonstration of the introduction of carotinoid pigment demands for completeness the support of microchemistry. The question at once arises if the pigment introduced in nervous and other body tissues is identical with the lipofuscin, "wear-and-tear," fat-holding pigment described for the nerve and other somatic cells as specific. While it is true that the micro-chemistry of the lipochrome pigments is superficial, which is the reason that the analysis by that means has hitherto failed, yet it must be emphasized that it has become quite sufficient to demonstrate this identity. The application of this chemistry was more simple in our problem when following a means of providing or withdrawing the pigment at will. The yellow pigment introduced in nerve cells and the chicken skin, and the pigment of the carrot in frozen sections give the fat stains, the oxidation and decolorization by hydrogen peroxid and ferric chlorid, the fat stains after oxidation, and the rapid solubilities in fat solvents in common with a supposed lipofuscin; while the most characteristic test for lipofuscin, the Nile blue stain of Hueck, equally applies to known lipochrome before and after its oxidation. This supposed metabolic pigment of the nerve cell is then identical with a true lipochrome.

Finally in corroboration of the species difference in the transferrence of the carotinoid pigment from plants, the cow as well as the chicken exhibits it in nerve cells, while swine with their colorless fat line up with the rabbit and dog in a complete absence. Man, who is best known to exhibit lipochrome, is also known to carry carotinoids in his blood serum, and has colored fat. The consistency is complete.

The lipochrome pigment of the nerve cell is therefore a plant carotinoid, derived from the food, but limited to such species as carry the carotinoids in the blood serum. The conception of it as a "wear-and-tear" pigment falls to the ground with its demonstration as an exogenous and fortuitous pigment. The melanin of the nerve cell is a true metabolic pigment, derived from nuclear materials and produced by chronic depression. Because of this, the conception of a "wear-and-tear" pigment is to be transferred to the melanin, as conditioned by agencies without the cell, with a restriction to the abnormal.

David H. Dolley,
Frances V. Guthrie
University of Missouri

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